

CALIFORNIA STRUCTURAL ENGINEER SEISMIC EXAMINATION

SAMPLE MULTIPLE CHOICE QUESTIONS

1. What component response modification factor R_p and component amplification factor a_p shall be used to design fasteners in the connection system for concrete cladding panels?
(6 points)
- A. $R_p = 3.0$ and $a_p = 2.5$
 - B. $R_p = 3.0$ and $a_p = 1.5$
 - C. $R_p = 3.0$ and $a_p = 1.0$
 - D. $R_p = 1.0$ and $a_p = 1.0$

Use the following information to answer Question 2.

CODE: • 2001 CBC

SPECIFICATIONS:

- Floor Joist Spacing = 15 inches, Span = 14 feet
- Floor Dead Load + Ceiling + Misc. = 18 psf
- Movable Partitions (use as Dead Load) = 20 psf

2. What is the maximum bending moment for a single joist for office occupancy?
(5 Points)
- A. 2,389 lb-ft
 - B. 2,695 lb-ft
 - C. 3,739 lb-ft
 - D. 5,882 lb-ft

Use the following information and Figures 8 and 9 to answer Questions 3 and 4.

A contractor has provided you with an incomplete detail shown in Figure 8 and the following information:

- CODE:**
- AISC ASD, 9th Edition
- MATERIALS:**
- Built-up Sections, Plates: A572 Grade 50 Steel, $F_y = 50$ ksi
 - Weld: E70XX Electrodes
 - Finish: All plates, shapes, and bolts will be hot dip galvanized.
- ASSUMPTIONS:**
- The movement at the joint would be detrimental to the serviceability of the structure.
 - Loads are not short-term loads.

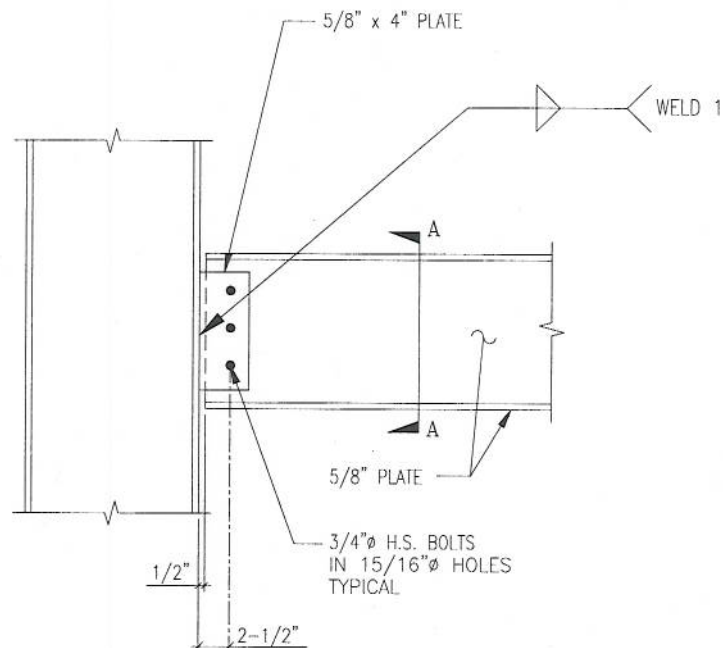
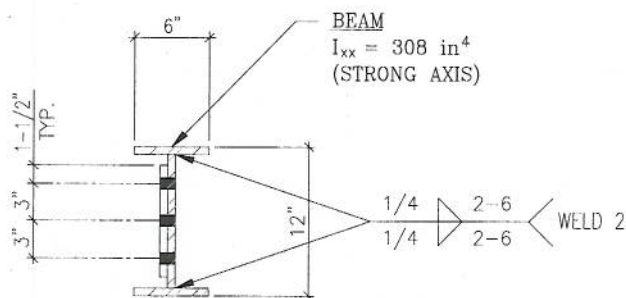


FIGURE 8
CONNECTION DETAIL



SECTION A-A

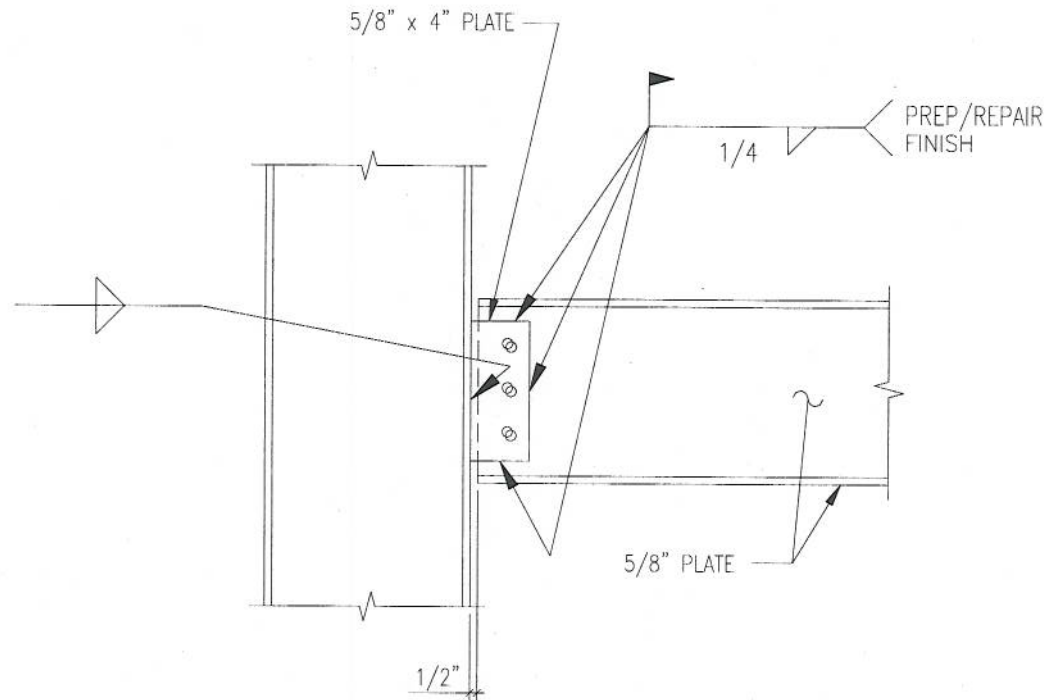


FIGURE 9
DETAIL

3. Which of the following bolt and connection types should you specify for the conditions given? (6 points)
 - F. A325-N
 - G. A325-SC
 - H. A490-SC
 - J. A307

4. The contractor has submitted a field change due to misaligned bolt holes as shown in Figure What is the maximum beam end reaction considering the capacity of the field weld only? (Use AISC tables for eccentric loads on weld groups). (7 points)
 - A. 33.6 kips
 - B. 38.5 kips
 - C. 40.0 kips
 - D. 40.6 kips

Use the following information and Figure 14 below to answer Question 5.

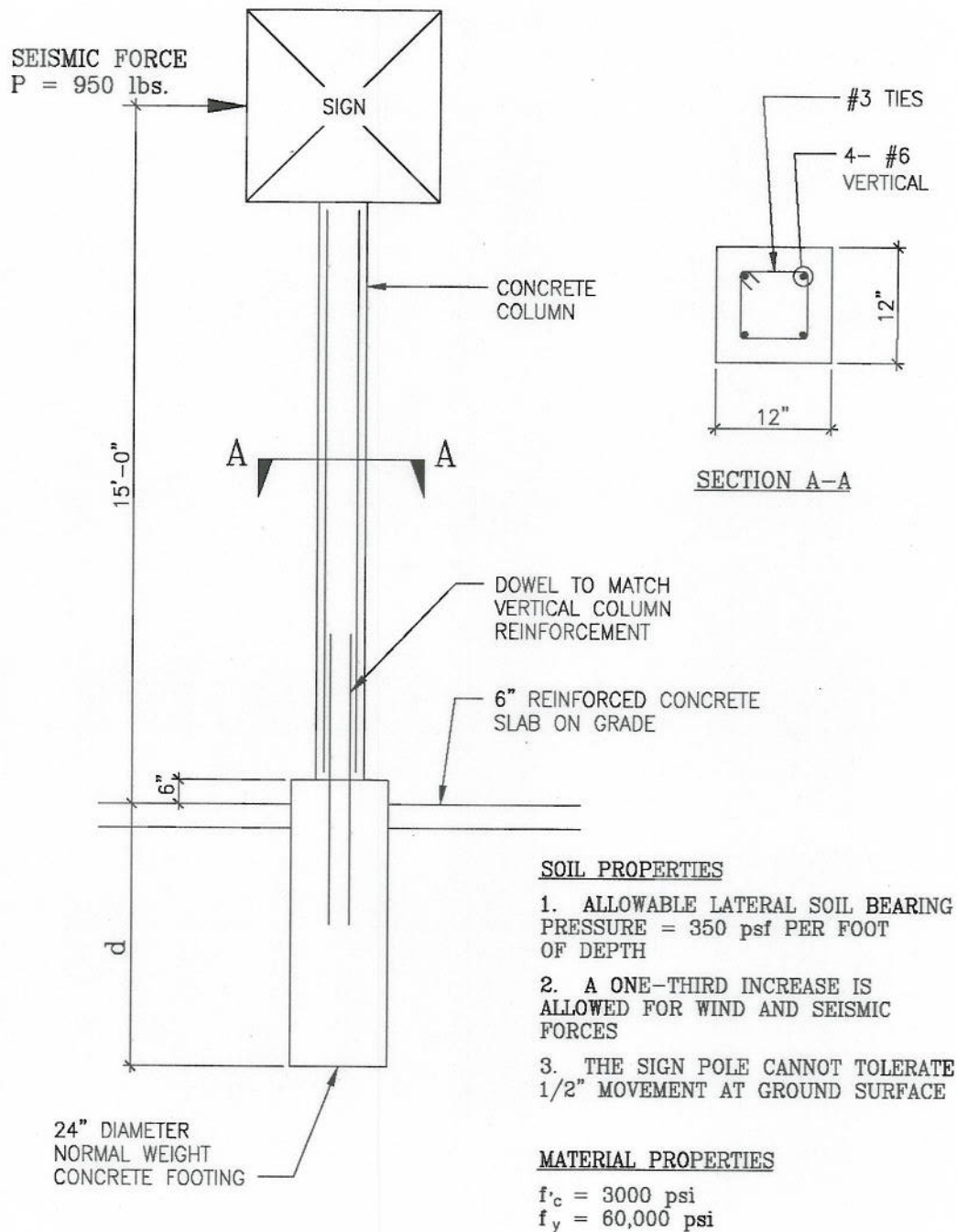


FIGURE 14

5. For the cantilever column shown, what is the minimum footing depth using the soil properties noted? (6 points)
- A. 3.8 feet
 - B. 4.5 feet
 - C. 6.6 feet
 - D. 7.1 feet

CALIFORNIA STRUCTURAL ENGINEER SEISMIC EXAMINATION

SAMPLE DESIGN QUESTIONS

PROBLEM B2 – Steel 110 Points

PROBLEM STATEMENT:

Use the information below and Figures 1 and 2 to answer the following Problem Requirements. Use the ASD method only and CBC design requirements.

A special concentric steel braced frame of a hospital building with seismic design loads at each level is shown in Figure 1. Figure 2 shows typical loading on all girders from level 2 through 7.

GIVEN INFORMATION:

- CODE:**
- 2001 CBC
 - AISC Manual of Steel Construction, (ASD) 9th Edition
- MATERIALS:**
- A572 ($F_y = 50$ ksi)
 - A500 Grade B, ($F_y = 46$ ksi)
- ASSUMPTIONS:**
- Foundation is adequate for all applied forces

PROBLEM REQUIREMENTS:

Solve the following in the Solution Booklet for Problem B2. Indicate which Problem Requirement you are answering and show all calculations. Make no additional assumptions unless instructed to do so.

1. Design member CE, using the lightest weight TS 8x8 A500 Grade B, ($F_y = 46$ ksi). Show that the selected member meets all applicable code requirements.
2. Design girder BD, using the lightest weight W36 section A572 ($F_y = 50$ ksi). Show that the selected member meets all applicable code requirements.
3. Design column AB using the lightest weight W14 Section A572 ($F_y = 50$ ksi) and assume axial loads as follows:
 - Dead Load = 277 k
 - Live Load = 81 k
 - Seismic Load = ± 658 k
 - Show that the selected member meets all applicable code requirements

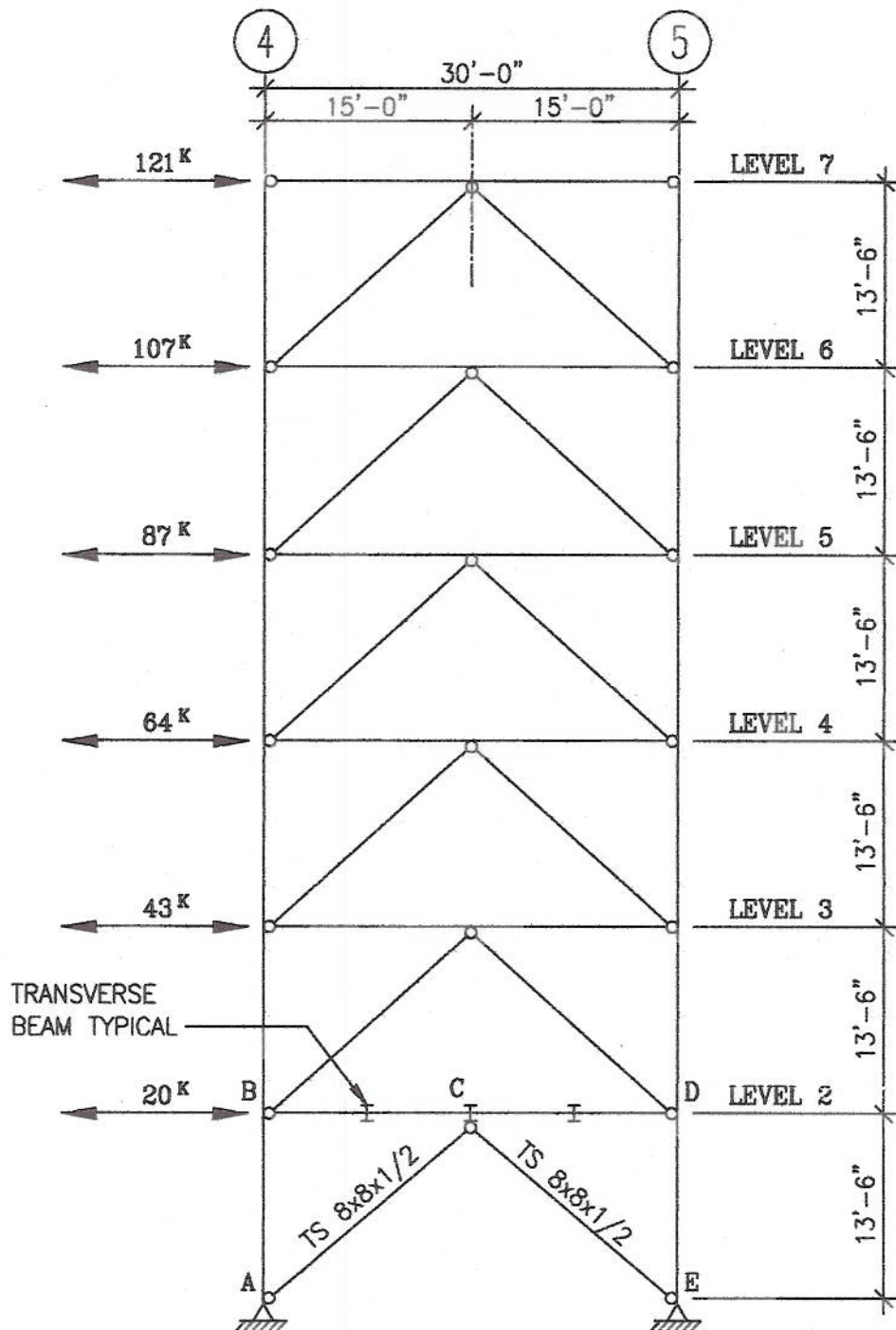


FIGURE 1
ELEVATION

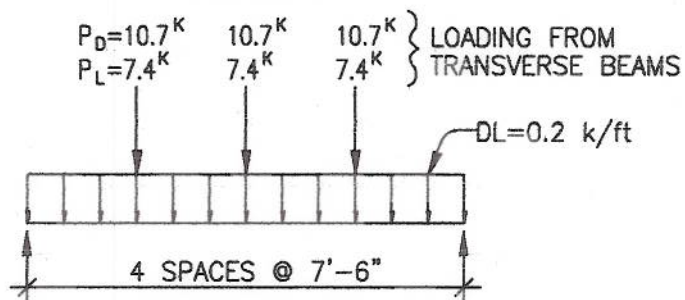


FIGURE 2
TYP. GIRDER LOADING

PROBLEM D1 – Concrete 210 Points

PROBLEM STATEMENT:

Use the following information and Figures CS1 through CS5 to answer the following Problem Requirements.

A three-story office building is shown in Figures CS1 and CS2. The building is constructed with concrete walls and floors.

GIVEN INFORMATION

- CODE:**
- 2001 CBC
- MATERIALS:**
- Concrete walls and floors – normal weight (150 pcf), $f_c = 3,000$ psi
 - Concrete roof – lightweight concrete (110 pcf), $f_c = 3,000$ psi
 - Reinforcement steel – ASTM A706, $f_y = 60,000$ psi
- SPECIFICATIONS:**
- Use #4 wall reinforcement, both horizontal and vertical except at boundary zones
 - Use #9 vertical bars at boundary zones
 - Seismic Zone 4
- ASSUMPTIONS:**
- The solid concrete wall and the concrete wall with openings have the same relative stiffness at each floor level
 - The wall reinforcement does not contribute to the flexural strength of the wall
 - Redundancy/reliability factor, ρ equals 1.0
 - All loads are provided at strength level in accordance with CBC 1612.2.1

PROBLEM REQUIREMENTS:

Solve the following in the Solution Booklet for Problem D1. Indicate which Problem Requirement you are answering and show all calculations. Make no additional assumptions unless instructed to do so. Credit for sketch will be given only for work completed on the Figure provided in the Solution Booklet for Problem D1.

1. The strength level seismic story forces and the base shear to the wall on Line D are shown in Figure CS2. Calculate the maximum strength level drag force at each end of the fourth floor beam. (21 Points)
2. Design the spacing of the #5 dowels shown in Figure CS4 at the roof. (21 Points)

PROBLEM REQUIREMENTS (continued):

3. For the drag beam shown in Figure CS3, verify that the longitudinal drag beam reinforcement is adequate at Point "A" as shown in Figure CS2. Use the assumptions shown below. (Ignore compression reinforcement). **(21 Points)**
 - $M_{DL} = 54$ k-ft (including beam self weight)
 - $M_{LL} = 20$ k-ft (based on floor live load of 50 psf)
 - $M_{seismic} = 46$ k-ft
 - Drag force = 42 kips
 - Use rectangular section for strength calculations
 - All given loads and moments are factored per CBC 1612.2.1
4. Calculate the longitudinal straight bar development length of all bars into the shear wall at Point A shown in Figure CS2. Detail the top and bottom longitudinal bars on the elevation on the Figure in your Solution Booklet for Problem D1. **(21 Points)**
5. Using #4 bars to resist the loads shown in Figure CS5, calculate the maximum spacing of the horizontal and vertical wall steel. **(10 Points)**
6. Verify if the boundary zone detailing is required according to the CBC, Section 1921.6.6.4. Calculate the boundary zone length if required. Assume the horizontal and vertical wall reinforcement is #4 at 10" on center. **(23 Points)**
7. Assume the boundary zone length is 36 inches. Calculate the minimum required boundary zone vertical reinforcement. Use #9 vertical bars and ignore wall reinforcement when considering flexure. **(25 Points)**
8. Calculate the minimum boundary zone confinement reinforcement using #4 ties. Assume 1 inch clear on all sides of a 36 inch long boundary zone. **(26 Points)**
9. Using the information given and calculated in items 6 through 8, complete the Figure in your Solution Booklet for Problem D1 showing the information noted below. **(42 Points)**
 - A. For the section shown, complete the sketch showing the following information:
 - Boundary zone vertical reinforcement
 - Horizontal wall reinforcement with anchorage detail
 - Boundary zone confinement reinforcement
 - B. For the wall elevation shown, complete the sketch showing the following information:
 - Location of splice in the vertical bars
 - Location of splice in the horizontal bars
 - Spacing of the boundary zone confinement reinforcing along the height of the wall (first story only)

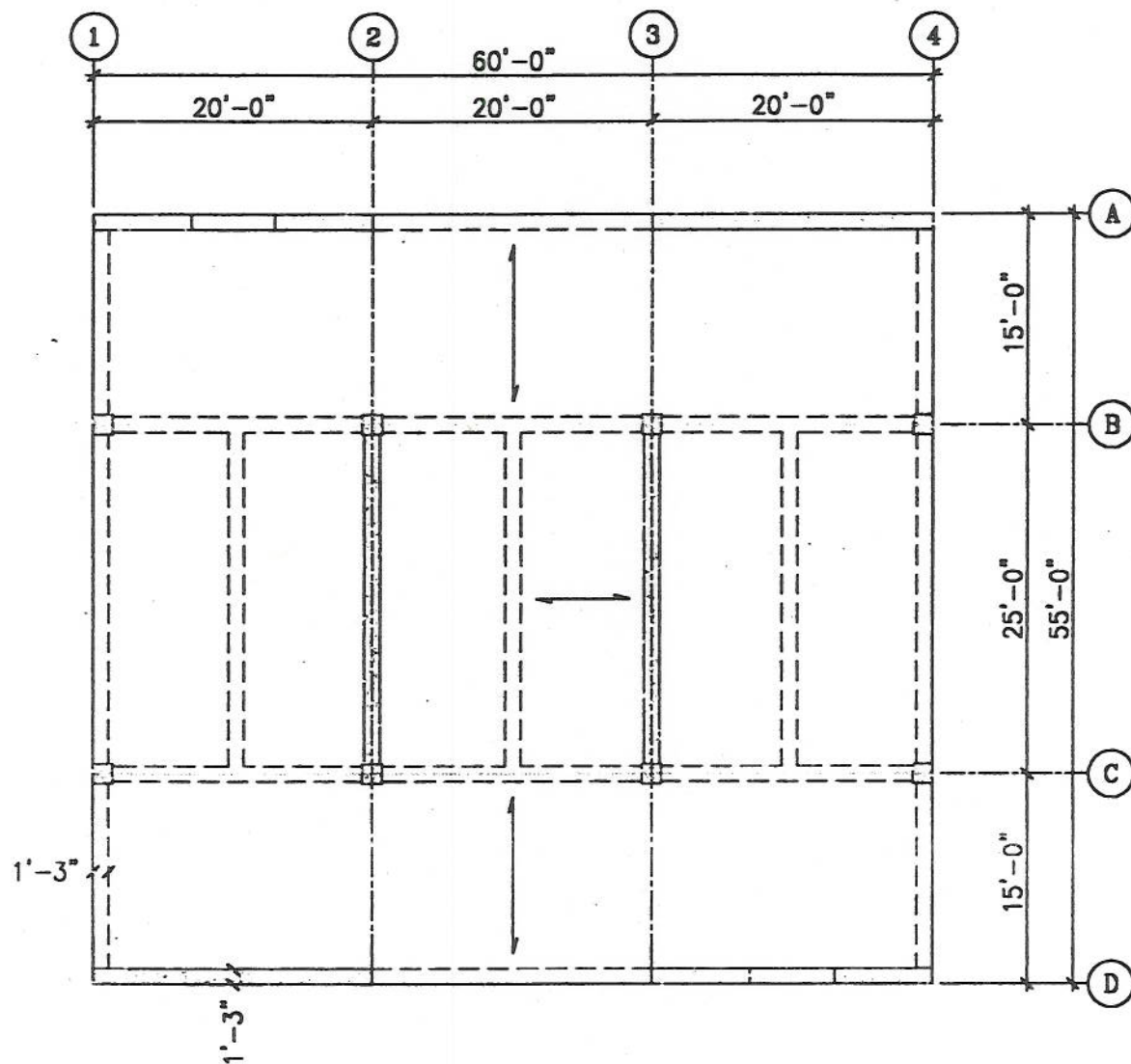


FIGURE CS1
TYPICAL FLOOR
FRAMING PLAN



NOTE
STORY FORCES SHOWN
ARE STRENGTH LEVEL
SEISMIC LOADS

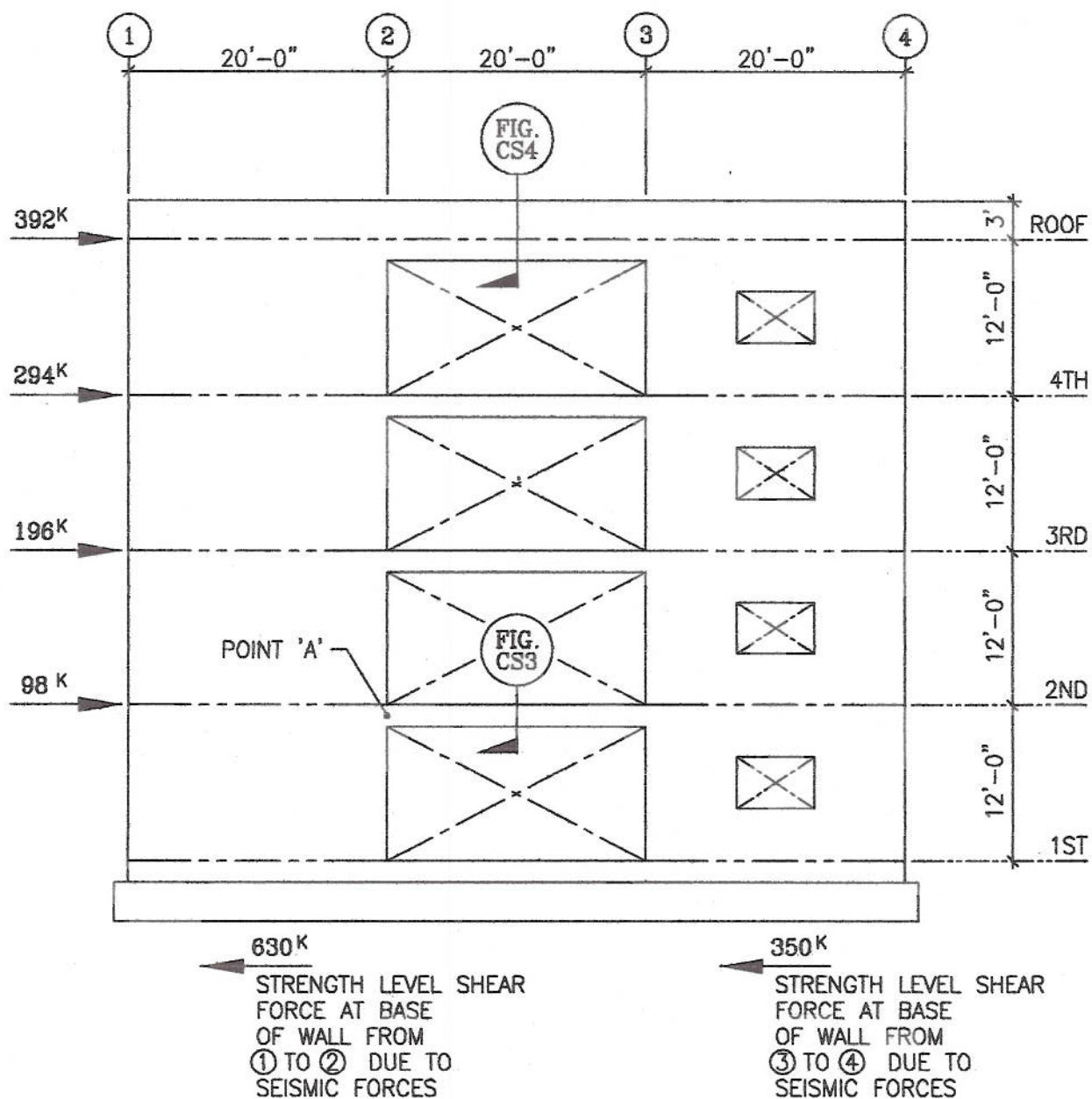


FIGURE CS2
ELEVATION OF WALL
ON LINE ①
ELEVATION OF WALL
ON LINE ② SIMILAR

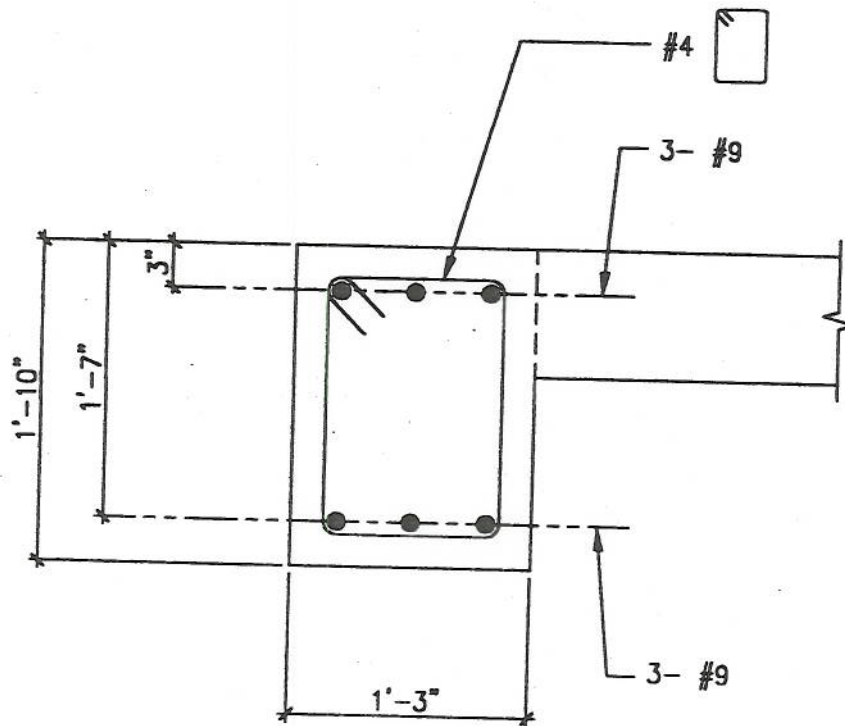


FIGURE CS3
SECTION @ DRAG BEAM

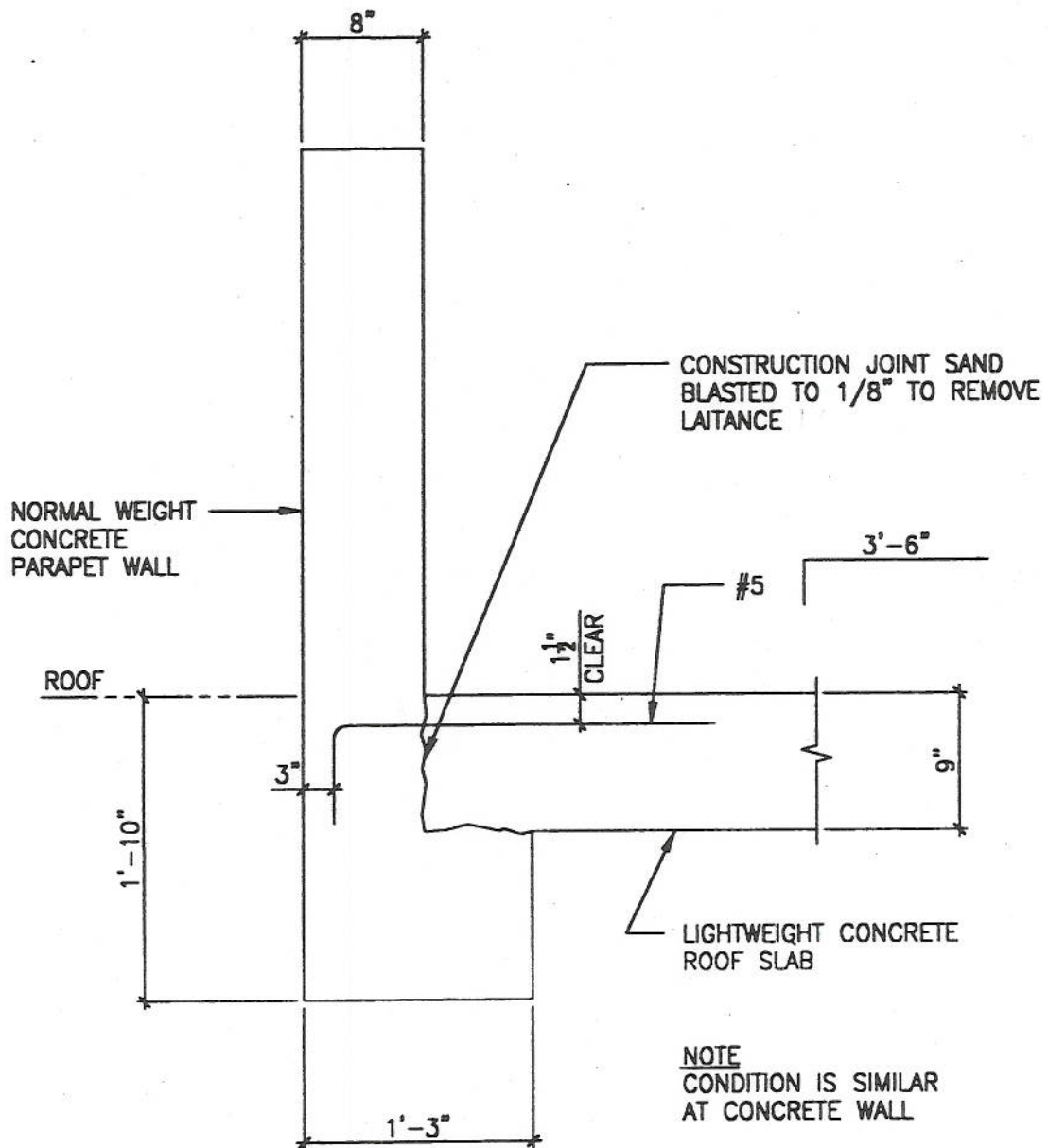
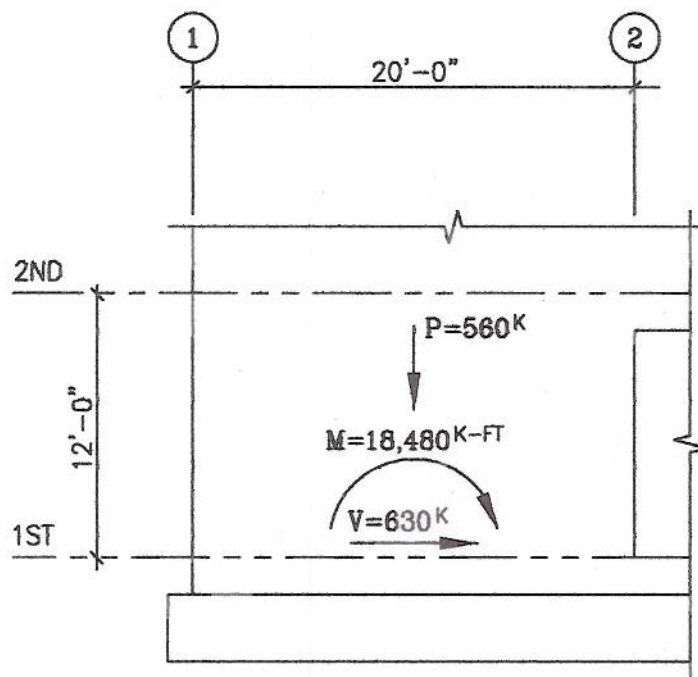


FIGURE CS4
SECTION @ ROOF BEAM

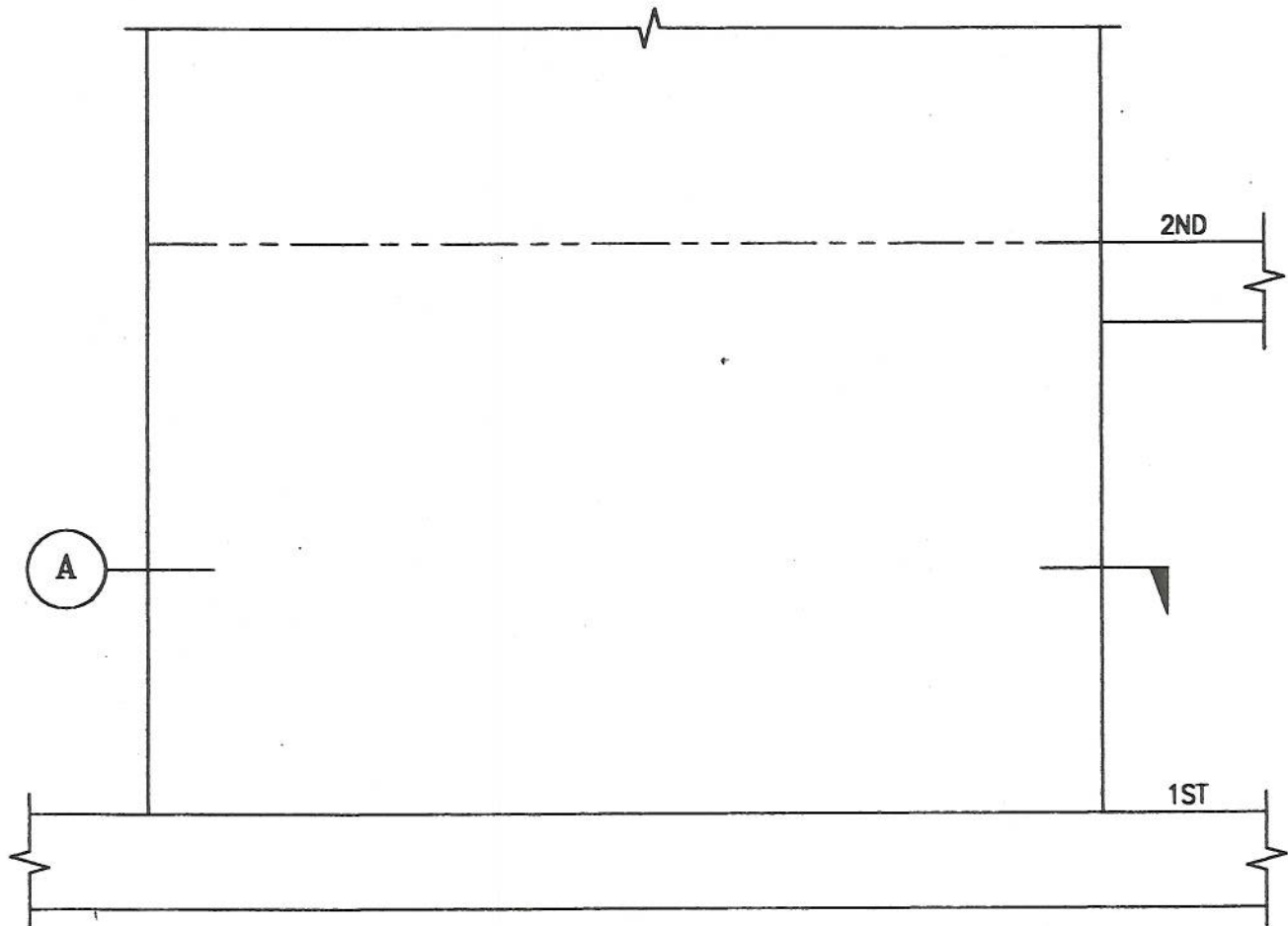


NOTE
ALL FORCES ARE AT
STRENGTH LEVEL

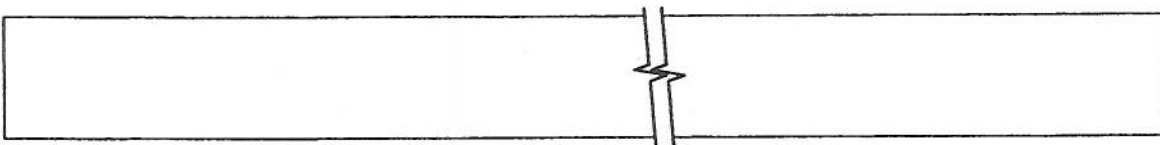
FIGURE CS5
ELEVATION

IT IS REQUIRED THAT YOUR DRAWING:

1. IS PROFESSIONAL IN APPEARANCE.
2. IS DRAWN WITH A STRAIGHT EDGE TO THE SCALE SPECIFIED BELOW.
3. IS LEGIBLE AND NEAT.
4. CONFORMS TO ACCEPTED DRAFTING STANDARDS.
5. CONTAINS SUFFICIENT INFORMATION SO THAT THE CONTRACTOR NEED NOT REFER TO OTHER DRAWINGS.



ELEVATION
 $1/4"=1'-0"$



SECTION A
 $1/2"=1'-0"$

PROBLEM D2 – Masonry
80 Points

PROBLEM STATEMENT:

Use the information below and Figure DS1 for the ground floor shear wall of a multi-story office building to answer the following Problem Requirements. The masonry building has no vertical or plan structural irregularity.

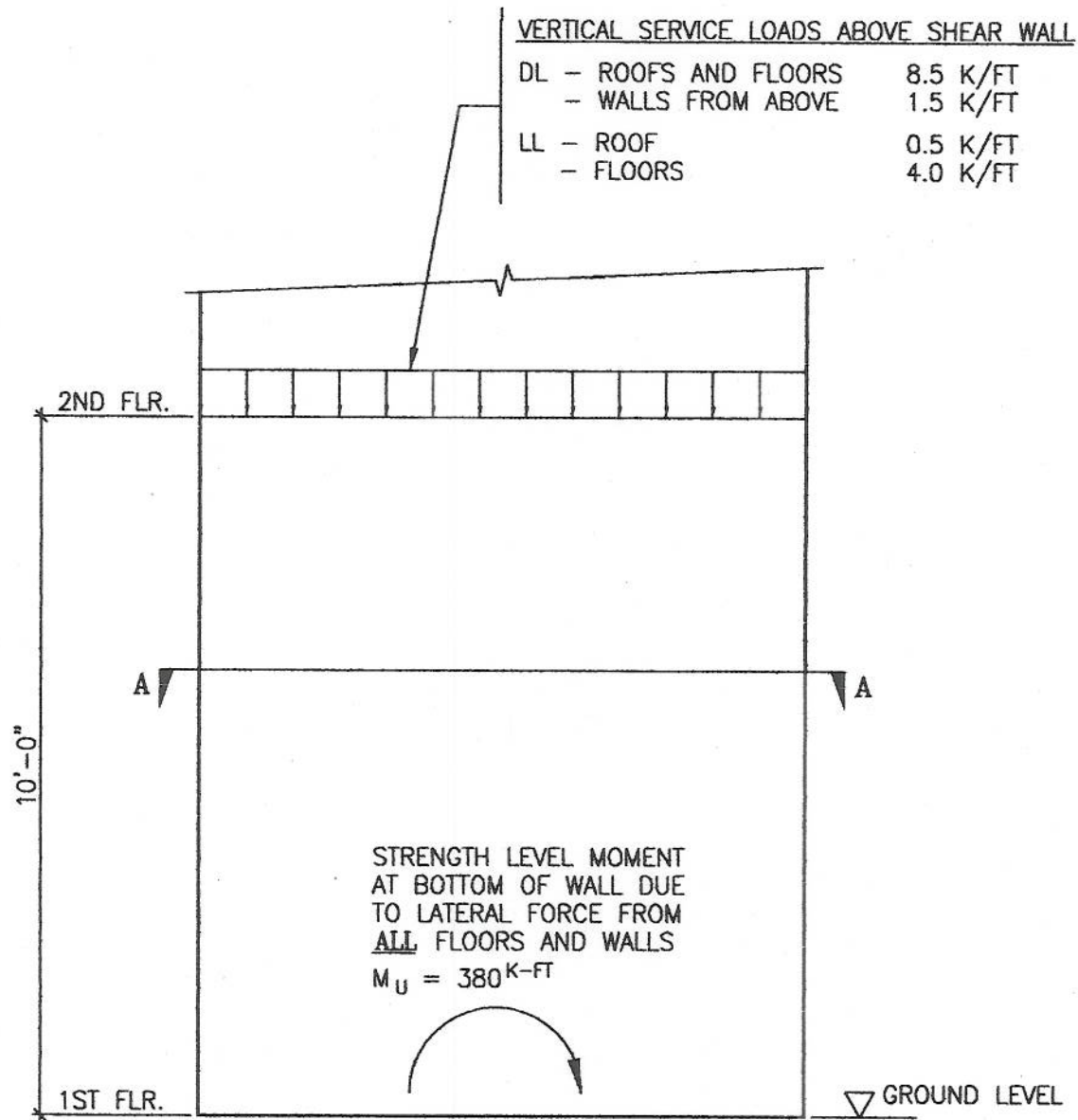
GIVEN INFORMATION

- CODE:**
- 2001 CBC
- SPECIFICATIONS:**
- $f'_m = 1500$ psi ; special inspection required
 - Reinforcing $f_y = 60,000$ psi
 - Weight of wall = 75 psf
 - Strength design
- ASSUMPTIONS:**
- Wind and Snow Loads do not apply
 - $f_t = 0.5$
 - $I = 1.00$
 - $C_a = 0.48$
 - Redundancy/reliability factor, ρ equals 1
 - Use $\phi = 0.65$ for axial load and moment

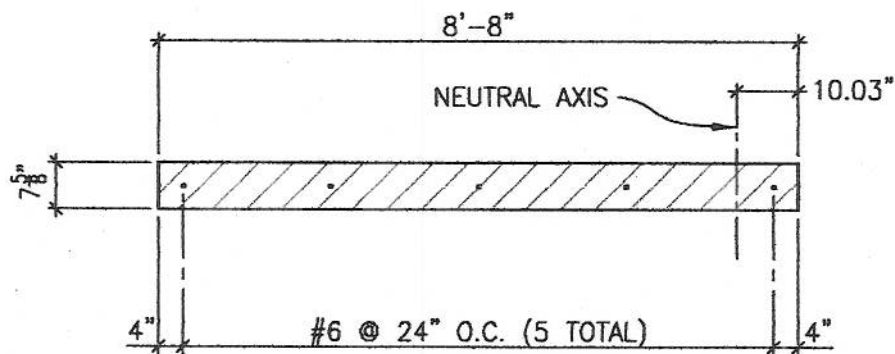
PROBLEM REQUIREMENTS:

Solve the following in the Solution Booklet for Problem D2. Indicate which Problem Requirement you are answering and show all calculations. Make no additional assumptions unless instructed to do so.

1. Calculate the 3 points (a, b and c) on the interaction diagram for the wall.
 - a) Vertical load only, “a”
 - b) In-plane moment only, using the given distance of neutral axis from compression edge, “b”
 - c) Axial load and moment at balanced strain conditions, “c”
 - d) Sketch the interaction diagram showing points a, b, and c. **(39 Points)**
2. For the given loads and moments, calculate all strength design axial load combinations per CBC and show them on the interaction diagram you have sketched. **(41 Points)**



WALL ELEVATION



SECTION A-A

FIGURE DS1

PROBLEM D3 – Wood

120 Points

PROBLEM STATEMENT:

Use the following information, Figure DS2 and Tables 1, 2 and 3 to answer the following Problem Requirements.

An existing wood stud wall is to be strengthened to perform as a shear wall for seismic loading shown in Figure DS2. It is proposed that straps A, B, C and D be nailed as shown, and that new hold downs and anchor bolts be installed with epoxy in existing stem wall. Existing plywood and sill plate shall not be replaced.

Allowable stress design loads are shown in the Figure DS2

GIVEN INFORMATION

CODE:

- 2001 CBC

MATERIALS:

- Straps = ASTM A653, Grade 33, 10 Gauge
- Existing Studs 2 x 4 at 16 inches on center. Douglas Fir Larch (North), Stud Grade

SPECIFICATIONS:

- Seismic Zone 4
- Dead loads shown **do not** include weight of the wall
- Redundancy/reliability factor, ρ equals 1.0
- Hold-downs or vertical straps are allowed only at end posts.

ASSUMPTIONS:

- Weight of wall = 10 psf
- 4 x 4 posts at ends of wall and king studs at window are adequate
- Allowable load on anchor bolts and nails can be increased **only** by 33% for seismic load
- Nails are common nails
- There are no existing hold-downs with anchors in the existing wood stud wall
- Horizontal straps must be designed for force transfers around the opening. Empirical method, tables, or charts should not be used.

PROBLEM REQUIREMENTS:

Solve the following in the Solution Booklet for Problem D3. Indicate which **Problem Requirement** you are answering and show **all** calculations. Make **no** additional assumptions unless instructed to do so. **Credit for sketch will be given only for work completed on the Figure provided in the Solution Booklet for Problem D3.**

1. Determine the tension in strap A due to lateral load only. (See Figure DS2-A for methodology) **(25 Points)**
2. Determine the number of 10d common nails required on strap A on either side of window. **(8 Points)**
3. Determine the number of 10d common nails required on each 4 x 4 post for straps C and D. **(15 Points)**
4. Use the attached tables 2 and 3 to determine the **minimum** size of hold-down, the bolt diameter, and the depth of embedment required in the stem wall. **(15 Points)**
5. Determine the number of $\frac{5}{8}$ inch diameter epoxy anchor bolts (see Table 1) on the sill plate for shear transfer to footing. (Ignore shear capacity of existing $\frac{1}{2}$ inch ϕ anchor-bolts). **(12 Points)**
6. Verify the nailing requirement for plywood, and specify changes if necessary. **(12 Points)**
7. On the Figure provided in your Solution Booklet for Problem D3, complete the details necessary for a contractor to perform the work. **(33 Points)**

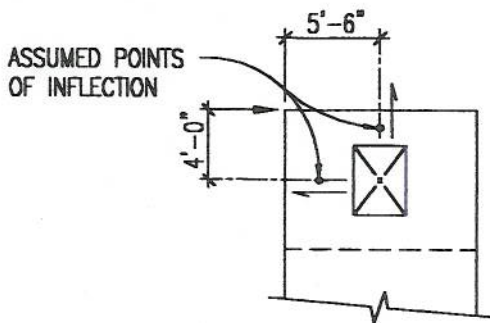


FIGURE DS2-A

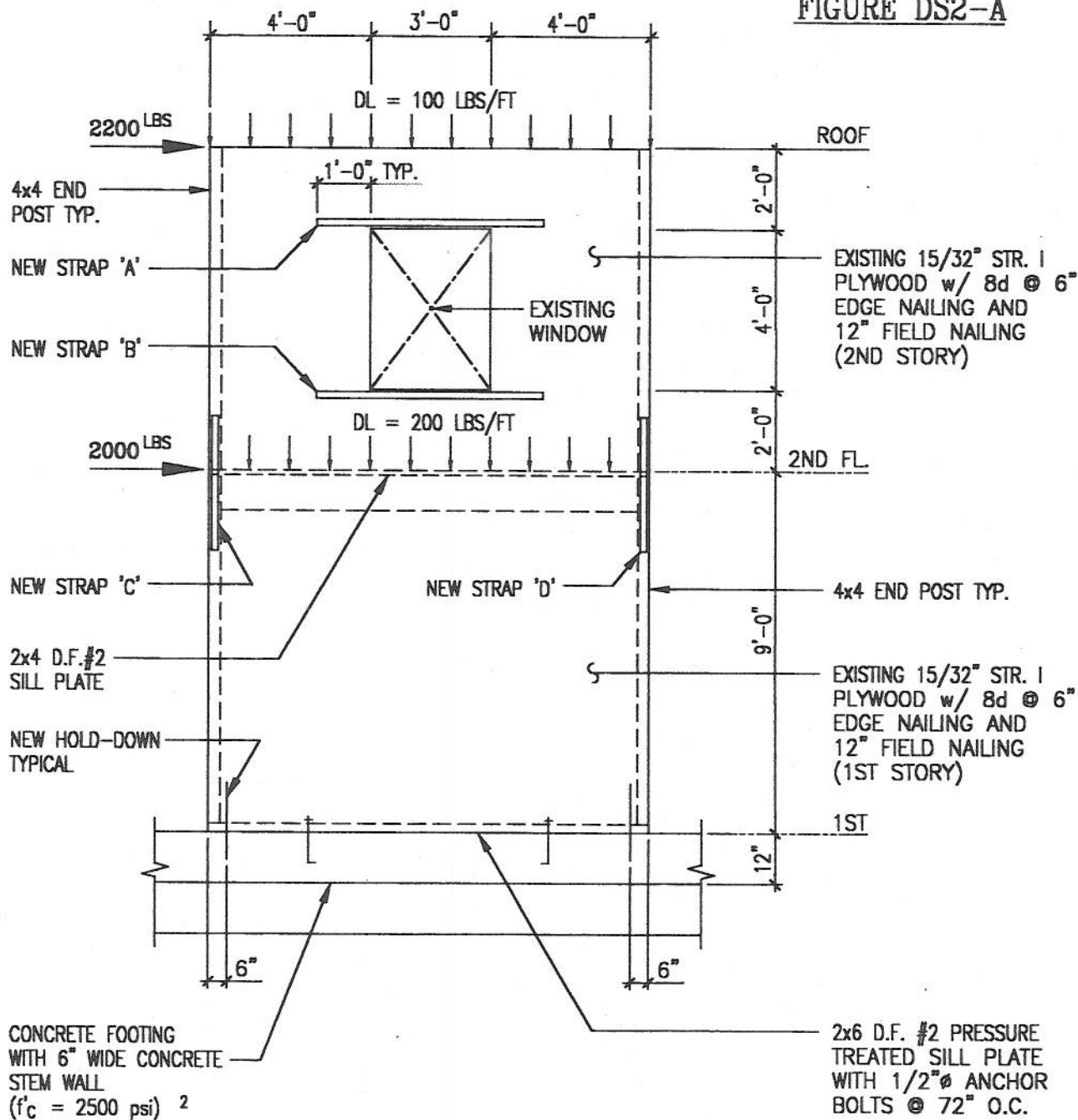


FIGURE DS2
EXISTING WOOD STUD
WALL ELEVATION

TABLE 1

Allowable Sill Plate Shear Loads (lbs) Parallel to Concrete Stem Wall for Simpson Set Epoxy Anchors Based on Concrete Strength

| Stud Dia (in) | Drill Bit Dia (in) | Min Embed (in) | Edge Dist (in) | End Dist (in) | Avg. Ult Shear Load (lbs) | Allow Shear Load * $f'_c \geq 2000 \text{ psi}$ |
|--------------------------|--------------------|----------------|----------------|---------------|---------------------------|--|
| Parallel to Plate | | | | | | |
| 1/2 | 5/8 | 4 1/4 | 1 3/4 | 6 3/8 | 8000 | 2826 |
| 5/8 | 3/4 | 5 | 1 3/4 | 7 1/2 | 8000 | 2946 |

Note: The allowable load for the connector will be the lesser of the wood bearing capacity or concrete strength.

TABLE 2

Allowable Tension Loads (lbs) for Threaded Rod Anchors installed in Concrete Foundation Stemwall

| Stud Dia (in) | Drill Bit Dia (in) | Min Embed (in) | Min Stem Wall Thickness (in) | Min Edge Dist (in) | Min End Dist (in) | Avg Ult Tension Load (lbs) | Allowable Tension Load * $f'_c \geq 2000 \text{ psi}$ |
|--|--------------------|----------------|------------------------------|--------------------|-------------------|----------------------------|--|
| SIMPSON SET EPOXY ANCHOR SYSTEM | | | | | | | |
| 5/8 | 3/4 | 10 | 6 | 1 3/4 | 5 | 23000 | 7665 |
| 7/8 | 1 | 15 | 8 | 1 3/4 | 5 | 33600 | 11200 |

TABLE 3

Allowable Tension Loads (lbs) on Hold-downs Based on Length of Bolt in Vertical Wood Member

| Model No. | Anchor Dia (in) | Stud Bolts | Length of Bolt in Vertical Wood Member (in)* | | |
|-----------|-----------------|------------|--|-------|-------|
| | | | 3 | 3 1/2 | 5 1/2 |
| HD2A | 5/8 | 2-5/8 | 2775 | 2775 | 2760 |
| HD5A | 5/8 or 3/4 | 2-3/4 | 3705 | 4010 | 3980 |
| HD6A | 7/8 | 2-7/8 | 4405 | 5105 | 5510 |

* Allowable loads have been increased 33% for seismic or wind loading with no further increase allowed.

